



March 2006

## Scramjet engine gears up for flight tests

by **Karen Y. Jackson, AFRL Public Affairs**

WRIGHT-PATTERSON AIR FORCE BASE, Ohio — Pentagon officials have officially designated the Air Force Research Laboratory's scramjet engine as the X-51A test vehicle, joining the ranks of experimental X-planes. The designation opens the door for researchers to flight test the revolutionary hypersonic engine, which has undergone extensive ground demonstrations.

"X-51A will explore powered atmospheric flight at speeds in excess of five times the speed of sound, in the so-called 'hypersonic' regime," said Air Force Chief Scientist Dr. Mark Lewis. He believes the X-51A program will build on decades of evolutionary research. "It will produce truly revolutionary capabilities, including high-speed weapons and new approaches for responsive space launch, but, for the first time, with a focus on practicality, including fuels, deployment, and concept of operations," Dr. Lewis said.

The development of the scramjet is critical to the evolution of hypersonic propulsion technology as it strives to develop revolutionary capabilities to warfighters. Hypersonic propulsion is an enabling technology for several potential systems such as reusable space lift vehicles and military weapons, which can be used to defeat time-critical targets at long ranges with a much faster response to adversary activities.

Although the scramjet testing is not complete, efforts are already underway to expand the scramjet technology base to establish scaling laws for larger scramjets, expand the operating envelope, and extend durability for reusable applications.

According to Robert Mercier, deputy for technology with AFRL's Propulsion Directorate, Aerospace Propulsion Division, hypersonics is the next great frontier in aeronautics. "When the X-51 flies, we will cross the threshold of that next frontier. With hypersonic cruise missiles, we could defeat time-critical targets from beyond the enemy's border with impunity. By combining hypersonic air-breathing propulsion with reusable rockets and high speed turbine engines, we could develop affordable on-demand access to space that would support military operations tempos."

During the X-51A flight tests, scheduled for December 2008 and January 2009, five to eight scramjet-powered free-flying vehicles will be launched from Edwards Air Force Base, Calif. According to Charles Brink, the directorate's scramjet engine demonstrator program manager, the X-51A will be dropped from a B-52 flying at 530 mph at 45,000 feet altitude and accelerated by a rocket booster to about five times the speed of sound. Then, the scramjet will accelerate the 16-foot long, 1,000 pound free-flying air vehicle to flight speeds between Mach 6 and Mach 7 (4,000 to 4,600 mph). Engineers hope the testing will demonstrate that the scramjet is operable and viable to propel a free-flying vehicle. Testing will also validate the computational codes and predictive tools used in scramjet development. The test-flight vehicle and engine will plunge into the ocean after the mission is complete.

"We are aiming for 600 nautical miles in 10 minutes or an average speed at Mach 6. We will have enough fuel and battery power to guarantee flight for five minutes and then after that, we will try to control it as best we can," Mr. Brink said.

If the scramjet performs the way creators believe it can, the X-51A program will set the foundation for several hypersonic applications including access-to-space.

Although Mr. Brink is amazed at the potential for the future of hypersonic systems, he has one goal. "A weapon might be a really neat thing that comes out of this, but what we are ultimately trying to do is get reusable, much more efficient propulsion for easier space access," he said.

To date, engineers have relied on ground testing facilities to obtain most of its data on scramjets, but because of limitations, researchers say real flight tests are essential and critical to future developments.

"Many of our designs were built based on the data collected during ground testing. Because many of our ground testing facilities are imperfect, this data represents approximations. These flight tests will confirm just how well the ground testing data relates to flight," Mr. Mercier said.

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Other limitations include the researchers' ability to test only at fixed Mach numbers. Nozzles are built to provide the conditions for fixed Mach numbers and don't take into account increases in Mach numbers. Lack of time and adequate ground testing facilities are other limitations researchers face. There are only a handful of available ground test facilities and researchers have less than a few minutes at best to collect data and complete testing.

Getting good in-flight data could save the Air Force a lot of time and resources. "If we find that our ground testing data is supported and verified by the in-flight testing, then we do not have to spend a lot of resources on flight tests in the future," Mr. Brink said.

This technology has been a long time in the making. The Air Force has been working on hypersonic flight since it replaced the National Aerospace Plane program in 1995 to help maintain aggressive developments in hypersonic technology.

For the past 10 years, AFRL's Propulsion Directorate has used a building block approach. "We worked on inlets, combustions, nozzles, fuel-cooled systems and structural components like uncooled, leading edges and fuel-cooled structures to keep the engine cool," Mr. Mercier said.

The Scramjet Demonstrator Program, jointly funded by AFRL and the Defense Advanced Research Projects Agency, is a \$212 million project.

Mr. Brink hopes the project will meet critical design review in January 2007. The scramjets are being built and designed by a consortium of companies that include Pratt & Whitney, Rocketdyne and Boeing Co. @

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